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Coprophilous fungi from Brazil: new records for the Neotropics

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Abstract—Twelve ascomycetes associated with herbivore dung, collected throughout an edaphic and climatic gradient from the Atlantic Forest complex to the semi-arid Caatinga in Pernambuco, Northeastern Brazil, represent new records: *Ascobolus castaneus, Arnium hirtum, Cercophora anisura, Chaetomium citrinum, C. spirale, Coniochaeta philocoproides, Coprotus albidus,* and *Delitschia vulgaris* are new records for the Neotropics; *Cercophora sordarioides, Chaetomium cochliodes, Sordaria lappae,* and *Thelebolus microsporus* are new records for Brazil. *Ascobolus castaneus* is recorded for the second time worldwide, revealing a much wider geographical distribution for a species previously reported only from China. Descriptions and updated geographic distributions are presented, and information regarding the records is discussed.

Key words—*Ascomycota*, dung fungi, taxonomy

Introduction

Coprophilous fungi constitute a rich and diverse ecological group of saprobes especially adapted to withstand conditions and use resources available in herbivore dung (Kirschner & al. 2015). These fungi can be found in dung of many herbivores, domesticated or wild, all over the world and throughout the year (Richardson 2001). Fungi on dung are represented mainly by members of *Ascomycota* (e.g., *Ascobolaceae*, *Lasiosphaeriaceae*), *Mucoromycota* (e.g., *Pilobolaceae*, *Mucoraceae*), and *Basidiomycota* (e.g., *Coprinaceae*, *Psathyrellaceae*). As in other ecological groups, a gradient ranging from specialized species to opportunistic saprobes can be found in coprophilous fungal communities (Newcombe & al. 2016). Despite this, the coprophilous mycobiota retains some similarity and shows somewhat regular patterns of occurrence and abundance throughout continents and time (Basumatary & McDonald 2017). The Brazilian coprophilous mycobiota is poorly known, and recent works have focused on the taxonomy and distribution of the most common genera and in establishing regional and national checklists (Calaça & al. 2014; Melo & al. 2012, 2017; Souza & al. 2017). As most coprophilous species are restricted to their substrates, their geographical distribution is only known where such inventories have been conducted, and some species thought to be restricted to temperate regions are being reported in the tropics as well. This work presents the first report of twelve records of *Ascomycota* associated with herbivore dung, all new records either for the Neotropics, South America, or Brazil.

Materials & methods

A total of 270 dung samples from goat, cattle, and horse were sampled between 2011 and 2013 from three animal precincts: (1) Universidade Federal Rural de Pernambuco, Veterinary Medicine Department, Recife (8°00′54″S 34°56′59″W), (2) Instituto Agronômico de Pernambuco (IPA), Caruaru (8°01′59″S 36°06′59″W), and (3) Instituto Agronômico de Pernambuco (IPA), Serra Talhada (7°54′59″S 38°17′00″W). These areas are located along a latitudinal transect of ~420 km in the state of Pernambuco, Northeastern Brazil and encompass two biomes: the Atlantic Rainforest to the east and the semiarid Caatinga to the west. Additional material, from Rio Grande do Sul state, were also received. Fresh dung samples were collected in clean plastic bags, taken to the laboratory, and incubated in moist chambers at room temperature (28 ± 2 °C) for at least 75 days under alternating natural light and dark periods. The material was observed directly on the substrata with the aid of a stereomicroscope, and ascomata (with or without their asexual morphs) were mounted in water, lactic acid, or lactophenol with cotton blue for identification under light microscopy.

Species were identified according to Ames (1961), Brummelen (1967), Kimbrough & al. (1972), von Arx & al. (1986), Bell (1983, 2005), Doveri (2004), Lundqvist (1972), and Richardson & Watling (1997). Careful review of the literature and national database searches were conducted to access information regarding previous records of coprophilous ascomycetes in Brazil. All voucher material was deposited at the Herbarium Padre Camille Torrend, Departamento de Micologia, Universidade Federal de Pernambuco, Recife, Brazil (URM). Additional information regarding all records and deposited specimens, along with high quality micrographs, are available at the INCT - Herbário Virtual da Flora e dos Fungos database website (http://inct.florabrasil.net).

Taxonomy

Dothideomycetes, Pleosporales, Delitschiaceae

Delitschia vulgaris Griffiths, Mem. Torrey Bot. Club 11: 104 (1901) FIG. 1A–C

PSEUDOTHECIA immersed, scattered, obpyriform, dark brown to black, 1275–1450 × 350–460 µm, with body adorned with light brown to golden, thin, flexuous, simple or branched hyphoid hairs with a slightly thickened wall, septate, about 1.5–2 µm diam., ≤150 µm long; NECK long, cylindrical, black, with papilliform rounded apex, 690–725 × 165–210 µm, tomentose; ASCI 8-spored, cylindrical, fissitunicate, uniseriate, 275–300 × 20–25.5 µm, with rounded apices and short stipe; ASCOSPORES 2-celled, with a medial septum, oblong-ellipsoid to fusoid, weakly constricted, with slightly narrowed ends, light brown when young, becoming dark brown at maturity, smooth, 32.5–37.5 × 13–15 µm; germ slits longitudinal, spanning the entire length of each cell.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBCUO: Recife,** Universidade Federal Rural de Pernambuco (UFRPE), on horse dung, 13.III.2012, R.F.R. Melo s.n. (URM86772a, b, c).

DISTRIBUTION—Europe (Sweden), North America (Canada, USA), Oceania (Australia). This is the first record for the Neotropics.

COMMENTS—The *Delitschia vulgaris* material from Brazil presents larger ascospores compared to the material cited by Luck-Allen & Cain (1975). Considering *Delitschia* species with tomentose pseudothecia and ascospores with a transverse septum, *D. araneosa* Cain is similar to *D. vulgaris*, but differs by its slightly narrower ascospores (10–11 µm; Luck-Allen & Cain 1975).

Leotiomycetes, Thelebolales, Thelebolaceae

Coprotus albidus (Boud.) Kimbr., Amer. J. Bot. 54: 22 (1967) FIG. 1D, E

APOTHECIA scattered, globose to lenticular, subhyaline to creamy-yellow, translucent, 300–600 µm diam., sessile, glabrous; MARGIN rounded, entire and smooth; DISK concolorous with the receptacle, scurfy to slightly villose due to the ascal protrusions; MEDULLARY EXCIPULUM with intricate cells (textura intricata); ECTAL EXCIPULUM composed of elongated cells, 7.5–10 µm diam.; PARAPHYSES cylindrical, becoming clavate towards the apex, enlarged to 5–6.5 µm wide, unbranched, septate, without visible refractive globules or pigments; ASCI 32-spored, clavate, with ascospores irregularly disposed, 80–110 × 22.5–30 µm, with a rounded apex; ASCOSPORES 1-celled, ellipsoid to elongated-ellipsoid, with tapered ends, hyaline, smooth, (7.5–)10–12.5 × 5–7.5(–10) µm, mostly with a de Bary bubble.

Specimen examined—**BRAZIL. Rio Grande du Sol: Santana do Livramento,** Área de Proteção Ambiental do Ibirapuitã, on horse dung, 13.VI.2015, Xavier de Lima s.n. (URM92164).

Distribution—Europe (Denmark, England, Finland, France). This is the first record for the Neotropics.

Comments—The material described here matches closely *C. albidus* as described by Kimbrough & al. (1972). Among *Coprotus* species with whitish to translucent apothecia bearing 32-spored asci and growing on dung, *C. albidus* can be confused with *C. rhyparobioides* (Heimerl) Kimbr., which presents larger asci (120–175 × 50–75 µm) and longer ascospores (13.5–17.5 × 7–8 µm), as well as paraphyses frequently branched toward apices (Kimbrough & al. 1972).

Thelebolus microsporus(Berk. & Broome) Kimbr.,
Ann. Rep, Inst. Ferment. Res. Osaka: 50 (1967) Fig. 1f, g

Apothecia scattered to gregarious, with cleistohymenial development pattern, initially globose to obpyriform, becoming cupulate to lenticular, exposing the disk later in the telohymenial phase, white to pale yellow, becoming yellowish to pale luteous, 95–250 µm diam., sessile, glabrous; margin rounded, entire and smooth; disk concolorous with the receptacle, almost smooth; hymenium ~45–100 µm thick; medullary excipulum and hypothecium undifferentiated; ectal excipulum composed of intertwined thick hyphae (textura epidermoidea), 7.5–12.5 µm diam.; Paraphyses cylindrical, branched, septate, 2–3 µm wide at the base, without visible refractive globules or pigments, branched close to its base and conspicuously broadened towards apices, enlarged up to 6 µm diam.; Asci 8-spored, cylindric-clavate, irregularly biseriate or uniseriate, 80–95 × 10–25 µm, with a short stipe, rounded above; Ascospores 1-celled, ellipsoid, with rounded ends, hyaline, smooth, 7.5–10 × 3–5 µm, occasionally with a de Bary bubble close to one end (absent when mounted in water).

Specimens examined—**BRAZIL. Pernambuco: Caruaru,** Instituto Agronômico de Pernambuco (IPA), on cattle dung, 16.X.2011, R.F.R. Melo s.n. (URM86783); on horse dung, 13.VI.2012, R.F.R. Melo s.n. (URM86784); **Serra Talhada,** Instituto Agronômico de Pernambuco (IPA), on goat dung, 21.IX.2011, R.F.R. Melo s.n. (URM86785).

Distribution—Antarctica, Europe (Austria, Denmark, England, Estonia, Faroe Islands, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland, Ukraine), North America (Canada USA), Oceania (Australia, New Zealand), South America (Argentina). This is the first record for Brazil.

Comments—Some measurements of the Brazilian material of *Thelebolus microsporus*, such as ascospore length and width, showed slight variation compared with material cultivated by Hoog & al. (2005) from Antarctica. This species differs from other 8-spored members of *Thelebolus* mainly by its developmental pattern: the apothecia expose their asci late in the mesohymenial or telohymenial phase, resulting in a typical apothecioid morphology, in contrast with species such as *T. globosus* Brumm. & de Hoog, which forms globose apothecia.

Pezizomycetes, Pezizales, Ascobolaceae

Ascobolus castaneus Teng, Sinensia 11: 109 (1940) Fig. 1h–j

Apothecia usually gregarious, with eugymnohymenial development pattern, initially globose to subglobose, becoming scutellate to discoid when mature, at first yellowish-brown, later chestnut brown, drying rust brown to finally blackish, 0.8–2 mm diam., sessile, almost glabrous; margin rounded, smooth, bending outwards with age; disk at first concave and yellow in maturation, finally convex, concolorous with the receptacle, smooth to slightly villose, not furfuraceous; hypothecium 30–47.5 µm thick, mostly with strongly compact, isodiametric cells (textura angularis); ectal excipulum composed of irregular ellipsoid cells, becoming more globose towards the margins (textura globosa near the margin, textura angularis near the base), 30–50 µm wide; Paraphyses cylindrical, branched, septate, 2–3 µm diam. at the base, with brownish intercellular pigment, slightly to not enlarged at the apex; Asci 8-spored, cylindric-clavate, irregularly biseriate or uniseriate, 120–175 × 15–17.5 µm, with a short stipe, rounded above; Ascospores 1-celled, ellipsoid, with rounded ends, at first hyaline, then brown to reddish brown, smooth, 21.5–26.5 × 11.5–12.5 µm.

Specimen examined—**BRAZIL. Pernambuco: Recife,** Universidade Federal de Pernambuco, on horse dung, 06.VI.2017, D.B.P. Monte s.n. (URM92165).

Distribution—Asia (China). This is the first record for the Neotropics.

Comments—*Ascobolus castaneus* is distinguished by its chestnut brown mature apothecia and completely smooth ascospores. It can be confused with other common members of *A.* sect. *Gymnascobolus* Brumm., such as *A. scatigenus* (Berk. & M.A. Curtis) Brumm., when young—both present similar apothecia up to the mesohymenial phase but can be immediately distinguished when mature. *Ascobolus scatigenus* has relatively large receptacles, white to pale luteous, furfuraceous disks composed of protruding asci with ellipsoid ascospores (22–24.5 × 10–15 µm according Melo & al. 2014), usually with a single to few oblique epispore fissures. The material was collected in situ on horse dung and not observed in moist chamber incubation like the others mentioned in this work. The ascospores are smaller than those in the Chinese material described by Van Brummelen (1972; 15–19.5 × 7.5–9 µm).

Sordariomycetes, Coniochaetales, Coniochaetaceae

Coniochaeta philocoproides (Griffiths) Cain,
Univ. Toronto Stud., Biol. Ser. 38: 65 (1934) FIG. 1K–O

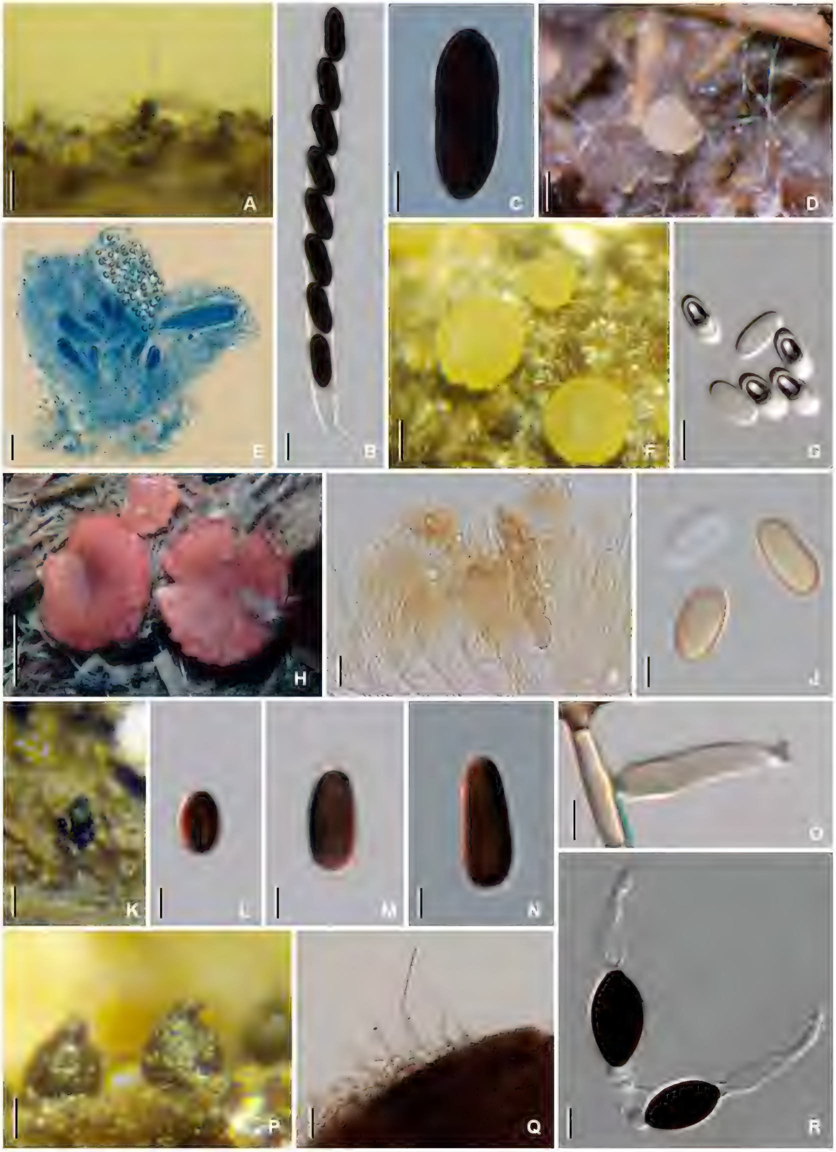
PERITHECIA scattered to gregarious, partially immersed, subglobose to obpyriform, brown to dark brown, 325–410 × 310–390 µm; NECK short, papilliform, occasionally indistinct; PERIDIUM membranaceous, opaque, dark brown, becoming dark brown to finally black towards the neck; HAIRS dark brown to black, rigid, usually straight, simple, thick-walled, non-septate, becoming thinner at the apex, abundant at the neck; ASCI 32-spored, cylindric to cylindric-clavate, irregularly triseriate to tetraseriate, 112–120 × 14–20 µm, with a short stipe, rounded above; ASCOSPORES 1-celled, variable in length, ellipsoid to oblong in frontal view, conical in lateral view, light brown to golden when young, becoming dark brown at maturity, smooth, 7.5–12(–22) × 57.5 µm, with a lateral straight germ slit through the entire length of the spore, without conspicuous gelatinous sheath; CONIDIOPHORES hyaline, simple or branched, septate; CONIDIOGENOUS CELLS enteroblastic, hyaline, consisting of discrete phialides, ampulliform to lageniform, 10–15(–22.5) × 2.5–3 µm, with cylindrical collarettes, 1–2 µm long; CONIDIA not observed.

SPECIMEN EXAMINED—**BRAZIL. PERNAMBUCO: Caruaru,** Instituto Agronômico de Pernambuco (IPA), on horse dung, 28.II.2013, R.F.R. Melo s.n. (URM86634).

DISTRIBUTION—Europe (Norway), North America (USA), and Oceania (New Zealand). This is the first record for the Neotropics.

COMMENTS—The specimen from Brazil matches closely the material described by Asgari & al. (2007). *Coniochaeta philocoproides*, a rare species reported on herbivore dung, is one of the few documented multispored species in this genus. Asci of *C. polymegasperma* M.J. Richardson are 64-spored, and its ascospores are longer (13–16.5 µm) and larger (9.5–13.5 µm) than *C. philocoproides*.

FIGURE 1. Brazilian dung fungi: ***Delitschia vulgaris***. A. pseudothecium on dung; B. ascus; C. mature ascospore, with two visible germ slits, once at each cell. ***Coprotus albidus***. D. apothecia on dung; E. mounted apothecium, with asci in different developmental stages. ***Thelebolus microsporus***. F. apothecia on dung; G. ascospores. ***Ascobolus castaneus***. H. apothecia on dung; I. hymenium,



with asci in different developmental stages; J. ascospores. ***Coniochaeta philocoproides***. K. perithecium on dung; L, M, N. ascospores from the same ascus, considerably different in length; O. phialide. ***Arnium hirtum***. P. perithecia on dung; Q. perithecial hairs; R. mature ascospores. Scale bars: A = 750 µm; B, E = 20 µm; C, J = 10 µm; D = 500 µm; F = 100 µm; G = 7.5 µm; H = 1 mm; I = 25 µm; K = 200 µm; L–O = 5 µm; P = 400 µm; Q = 2.5 µm; R = 15 µm.

Coniochaeta hansenii (Oudem.) Cain is reported with 64–128-spored asci and slightly different ascospore measurements (6–9 × 5–9 μm) (Asgari & al. 2007).

Sordariomycetes, Sordariales, Lasiosphaeriaceae

Arnium hirtum (E.C. Hansen) N. Lundq. & J.C. Krug,
Symb. Bot. Upsal. 20(1):218 (1972) FIG. 1P–R

PERITHECIA scattered to isolated, semi-immersed to superficial, obpyriform, 690–930 × 480–540 μm, reddish brown to dark brown, translucent, covered by hyphoid, slender, flexuous hairs, septate, 2–2.5 μm thick; NECK cylindrical to conical, opaque, 150–165 × 130–140 μm, tomentose, neck hairs more rigid and setose, ≤7 μm long, becoming thinner towards the apex; PERIDIUM membranaceous, subopaque to olivaceous brown, darkening towards the neck to finally black, 3-layered—outer peridial layer composed of large, inflated, angular cells, thick-walled, 5–10 μm diam., forming a short palisade that resembles inflated perithecial hairs; PARAPHYSES interspersed with the asci, ventricose, persistent or collapsing; ASCI 8-spored, cylindric to cylindric-clavate, 350–400 × 25.5–35.5 μm, usually persistent, with rounded apex and a long stipe; ASCOSPORES at first fusoid to ellipsoid, hyaline, later becoming ochraceous to olivaceous brown, with several oil droplets, and finally dark brown, bicaudate; 35–47.5 × 18.5–22.5 μm, with an eccentric germ pore; APICAL CAUDA single, 7.5–9 μm diam., becoming thinner towards its apex, up to 42.5 μm long, usually persistent in mountings, longitudinally striped, covering the germ pore; BASAL CAUDA similar in morphology, slightly thinner and longer, 5–6 μm wide at the base when not inflated, up to 50 μm long, persistent or collapsing when mounted.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBUCO: Serra Talhada,** Instituto Agronômico de Pernambuco (IPA), on goat dung, 24.X.2011, R.F.R. Melo s.n. (URM86719); , Universidade Federal Rural de Pernambuco (UFRPE), on horse dung, 23.III.2012, R.F.R. Melo s.n. (URM86720).

DISTRIBUTION—Africa (Morocco), Europe (Belgium, England, Denmark, France, Germany, Ireland, Norway, Scotland, Sweden) and North America (USA). This is the first record for the Neotropics.

COMMENTS—*Arnium* species are distinguished from other dark-coloured perithecial dung ascomycetes by their unicellular ascospores with gelatinous caudae at both ends. *Arnium hirtum* presents a wide array of morphological variation, having as its main characteristics the substrate (herbivore dung) and the ascospore morphology: equilateral, non-septate and bicaudate (35–47.5 × 18.5–22.5 μm). The present material fits well with the description of the

European specimens (Lundqvist 1972), with similar measurements and general morphology. It is a common species in Europe, but rare outside that continent, although more surveys will probably reveal new records for tropical areas.

Cercophora anisura N. Lundq., Symb. Bot. Upsal. 20(1): 91 (1972) FIG. 2A, B

PERITHECIA isolated, semi-immersed, obpyriform, subglobose or conical, 480–515 × 350–400 µm, light brown to golden, translucent, covered by hyphoid, flexuous, occasionally branched hairs, about 2 µm thick; NECK cylindrical to conical, opaque, carbonaceous, dark brown to finally black close to the apex, 100–110 × 80–100 µm, adorned with tufts of short, inflated and agglutinated hairs, 2–2.5 µm thick, septate, concolorous with the peridium in the lower part of the perithecium; PERIDIUM pseudo-parenchymatous, membranaceous, subopaque, darkening towards the neck to finally black, 3-layered—outer peridial layer composed of angular to rounded cells, thin-walled, 4–9 µm diam.; PARAPHYSES interspersed with the asci, ventricose, persistent or collapsing; ASCI 8-spored, cylindric-clavate, 175–225 × 17.5–25 µm, with a long stipe and tapered apex, thickened, simple apical ring present; subapical globule subglobose to ellipsoid, smooth to slightly verrucose, 4–5 µm diam.; ASCOSPORES at first cylindrical vermiform to slightly sigmoid, hyaline, with several oil droplets, occasionally geniculate at the base, non-septate, smooth, bicaudate, later becoming swollen in the upper part and finally 2-celled after the formation of a transverse septum, delimiting the region of the spore that will become the pigmented head cell above, and another part for the hyaline pedicel below, irregularly biseriate to triseriate; HEAD CELL ellipsoid, truncated at the base, non-septate, brown to dark brown, smooth, 15–19 × 7.5–8 µm with an eccentric germ pore; PEDICEL cylindrical, hyaline, occasionally geniculate near the base, usually collapsing, 30–35 × 4–5 µm; APICAL CAUDA single, cylindrical to conical, tapering towards the apex, 10–20 µm long, 2–2.5 µm diam. at the base, usually collapsing; BASAL CAUDA similar in morphology, thicker and longer, 20–28.5 × 3–3.5, usually collapsing.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBUCO: Recife,** Universidade Federal Rural de Pernambuco (UFRPE), on horse dung, 11.XII.2012, R.F.R. Melo s.n. (URM86721a, b, c).

DISTRIBUTION—Europe (Sweden). This is the first record for the Neotropics.

COMMENTS—The Brazilian material was sparse and little information regarding its morphological variation is presented here. *Cercophora anisura* was proposed by Lundqvist (1972) in his monographic treatment of the Nordic *Sordariaceae* from material on cattle dung in Sweden. The species can be confused with *C. mirabilis* Fuckel, one of the most common *Cercophora* on herbivore dung, which differs by its larger perithecia (650790 × 340475 µm), longer inflated hairs (2–3.5 µm), and ascospores with even caudae (Lundqvist 1972). In our material of *C. anisura*, mature ascospores with multiseptate pedicels, ascospores with both cells pigmented, and ascospores without the transverse septum were commonly observed.

Cercophora sordarioides (Speg.) N. Lundq.,
Symb. Bot. Upsal. 20(1): 112 (1972) Fig. 2c–e

Perithecia scattered to isolated, semi-immersed to superficial, obpyriform, subglobose or conical, 650–850 × 550–600 µm, olivaceous to golden, translucent, glabrous; neck conical to slightly cylindrical, opaque, carbonaceous, dark brown to finally black close to the apex, 200–350 × 190–200 µm; Peridium pseudo-parenchymatous, membranaceous, subopaque, darkening towards the neck to finally black, 3-layered—outer peridial layer with angular to rounded cells, thin-walled, 7–10(–12.5) µm diam.; Paraphyses interspersed with the asci, filiform, persistent or collapsing; Asci 8-spored, clavate, 155.5–185 × 17.5–25 µm, with a long stipe and tapered apex, thickened, simple apical ring present; subapical globule subglobose to globose, smooth to slightly verrucose, 4–5.5 µm diam.; Ascospores at first cylindrical to sigmoid, hyaline, with several oil droplets, occasionally geniculate at the base, non-septate, smooth, bicaudate, later becoming swollen in the upper part and finally 2-celled after the formation of a transverse septum, delimiting the region of the spore that will become the pigmented head cell above, and another part for the hyaline pedicel below, irregularly biseriate to triseriate; head cell ellipsoid, truncated at the base, usually with an eccentric transverse septum, brown to dark brown, smooth, 17.5–22.5 × 7.5–11 µm with a apical or subapical germ pore; pedicel cylindrical, hyaline, occasionally geniculate near the base, persistent or collapsing, 45.5–49 × 29.5–31 µm; apical cauda single, cylindrical, tapering towards the apex, 27.5–55 µm long, 2.5–3 µm wide at the base, usually collapsing; basal cauda similar in morphology.

Specimen examined—**BRAZIL. Pernambuco: Caruaru,** Instituto Agronômico de Pernambuco (IPA), Caruaru, on horse dung, 23.XI.2012, R.F.R. Melo. s.n. (URM86728).

Distribution—Europe (Sweden). This is the first record for the Neotropics.

Comments—*Cercophora sordarioides* is regarded as a rare species. It was reported from Argentina by Spegazzini. The key characteristics are the glabrous, olivaceous to dark-yellow perithecia with thin-walled peridial cells and ascospores with septate head cells. The Brazilian material presents longer pedicels in relation to Argentine material (37–38 µm), as described in Lundqvist (1972).

Sordariomycetes, Sordariales, Chaetomiaceae

Chaetomium citrinum Udagawa & T. Muroi,
Trans. Mycol. Soc. Japan 22: 15 (1981) FIG. 2F–H

PERITHECIA scattered to isolated, superficial, subglobose to obovoid, yellowish to greenish in mass, dark brown when isolated, 250–300 × 240–280 µm, attached to the substrate by weakly pigmented rhizoids, light brown to brown, thin-walled, dichotomously branched, non-septate, flexuous, usually smooth, 2.5–2.8 µm diam.; TERMINAL HAIRS of one type — numerous, septate, wavy to loosely coiled, forming distant and weakly organized coils along its length, making 2–3 convolutions, 2.4–3 µm diam., with almost constant diameter in each turn towards the apex, light brown to golden, becoming less pigmented close to the apex, extending up to 400(–450) µm, markedly punctate in all its extension, clustered above to form a strongly compact sporiferous head above the perithecium, ellipsoid to columnar; LATERAL HAIRS slightly similar in morphology — numerous, long, filiform, tortuous, smooth, sparsely septate, thin-walled, light brown to golden, slightly less pigmented than the terminal hairs, 1.9–2.4 µm, extending up to 350 µm; PERIDIUM pseudo-parenchymatous, membranaceous, fragile, with flattened, angular to elongate, slightly thick-walled cells; ASCI 8-spored, clavate, spore-bearing part 9–12.5 µm diam., with a short stipe, evanescent; ASCOSPORES variable in shape, ellipsoid, long-ellipsoid, ovoid, fusoid to limoniform, biapiculate or not, dark brown when mature, smooth or with superficial cracklings, 7.4–10.6 × 4.8–6.5 µm.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBUCO: Caruaru,** Instituto de Pesquisas Agronômicas, on goat dung: 27.II.2012, R.F.R. Melo s.n. (URM86708), 25.VI.2012, R.F.R. Melo s.n. (URM86709a, 86709b), **Recife,** Universidade Federal Rural de Pernambuco (UFRPE), on goat dung, 16.IV.2012, R.F.R. Melo s.n. (URM86710).

DISTRIBUTION—Asia (Japan), North America (Canada). This is the first record for the Neotropics.

COMMENTS—*Chaetomium citrinum* presents a striking diagnostic feature of greenish-yellow perithecia, especially when occurring in groups. Ascospore shapes are quite variable in this species, even irregular or with protuberances. It is a rarely encountered species of *Chaetomium*. The present material has larger perithecia than the Japanese strain (160–250 µm), as described by von Arx & al. (1986).

Chaetomium cochliodes Palliser, N.Amer. Fl. 3(1): 61 (1910) FIG. 2I–K

PERITHECIA scattered to isolated, superficial, subglobose to doliform, grayish in stereomicroscopy, dark brown to black when mounted, 310–340

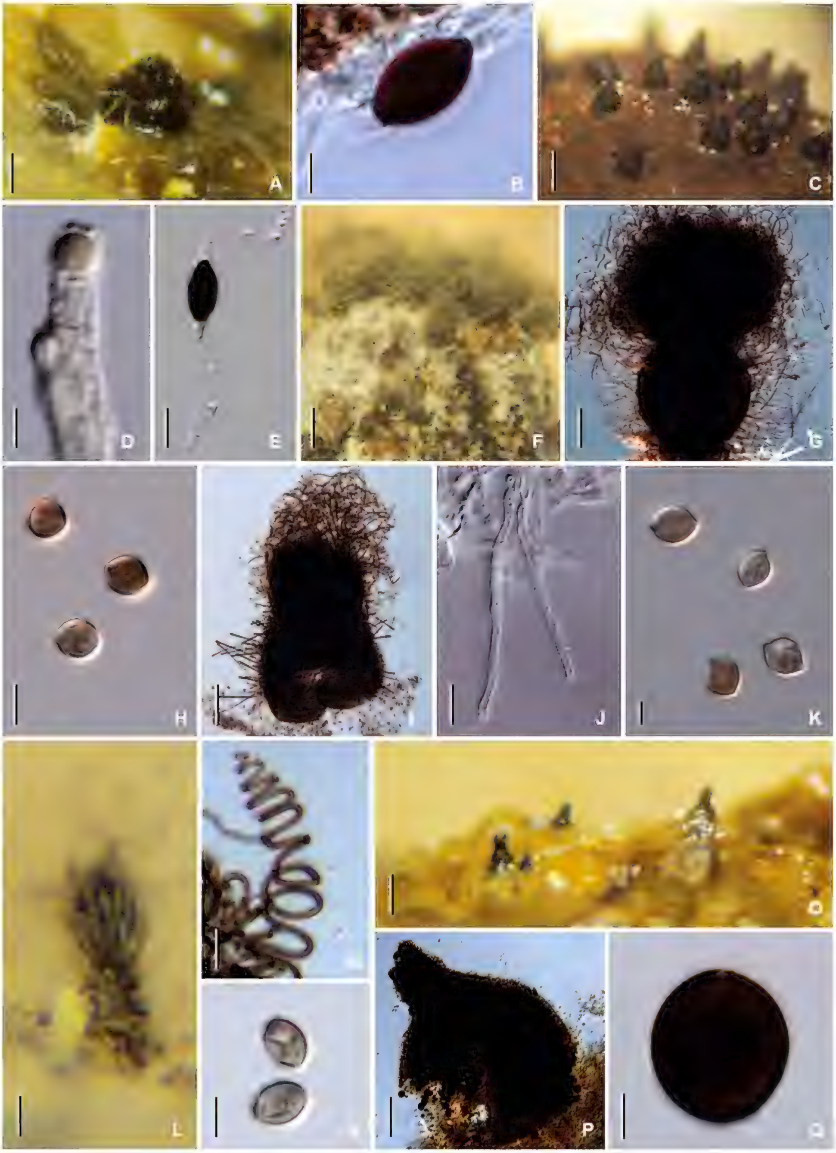
× 280–295 µm, attached to the substrate by hyaline, thin-walled rhizoids, 1.5–2.5 µm diam.; TERMINAL HAIRS of two types — (1) initially straight, from the proximal end until up to half of its length, becoming loosely spaced and coiled toward the apex, making 3–4 convolutions and progressively smaller in diameter ("corkscrew" type), brown to golden, becoming less pigmented close to the apex, extending up to 300 µm above the sporiferous head, 5–7.5 µm diam., smooth to roughened, without conspicuous septa, loosely clustered to form a weakly compact sporiferous head above the ascoma; (2) wavy, thinner, flexuous, septate, not forming coils, projecting above the sporiferous head, usually intertwined with the coiled hairs, markedly roughened, olivaceous brown to pale brown, up to 3 µm diam.; LATERAL HAIRS numerous, long, filiform, tortuous, smooth, septate, thin-walled, light brown to golden, slightly less pigmented than the terminal hairs, 3.5–5.5 µm, extending ≤200 µm, slightly bulbous at the base; PERIDIUM pseudo-parenchymatous, membranaceous, fragile, with flattened, angular to slightly elongate, slightly thick-walled cells, 7.5–15 µm diam.; ASCI 8-spored, clavate, spore-bearing part 30–40 × 15–22.5 µm, with a short stipe, evanescent; ASCOSPORES limoniform, biapiculate, light brown to olivaceous brown when mature, smooth, 8.5–10 × 7–8 µm.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBUCO: Serra Talhada,** Instituto Agronômico de Pernambuco (IPA), on goat dung, 16.V.2012, R.F.R. Melo s.n. (URM86711a, b, c).

DISTRIBUTION—Africa (South Africa), Asia (India, Japan, Nepal), Europe (Belgium, England, Netherlands, Norway), North America (Canada, USA), and South America (Argentina). This is the first record for Brazil.

COMMENTS—*Chaetomium cochliodes* is a common species in indoor air samples, occasionally reported in herbivore dung. The material examined in Brazil was consistent with the protologue description: terminal hairs of two types: one long, simple, becoming coiled above the sporiferous head, and the other type septate, wavy, usually rough-walled. It can be confused with *C. globosum* Kunze, a common species with wide circumscription, but differing by the thinner terminal hairs (3.5–4.5 µm) and larger ascospores (9–12 × 7.5–8 µm) (Ames 1961).

FIGURE 2. Brazilian dung fungi: ***Cercophora anisura***. A. perithecium on dung; B. ascospore. ***Cercophora sordarioides***. C. perithecia on dung; D. ascal apical globule; E. mature ascospore. ***Chaetomium citrinum***. F. perithecia on dung; G. mounted perithecium; H. ascospores. ***Chaetomium cochliodes***. I. mounted perithecium; J. perithecial rhizoids; K. ascospores.



Chaetomium spirale. L. perithecium on dung; M. coiled terminal hair; N. ascospores. ***Sordaria lappae***. O. perithecia on dung; P. mounted perithecium; Q. ascospore. Scale bars: A, F = 250 µm; B = 7.5 µm; C = 750 µm; D, K, Q = 5 m; E, M = 15 µm; G = 100 µm; H, J, N = 10 µm; I = 150 µm; L, P = 50 µm; O = 300 µm.

Chaetomium spirale Zopf,Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 42(5): 275 (1881) FIG. 2L–N

PERITHECIA scattered to isolated, superficial, globose to ovoid, grayish in stereomicroscopy, dark brown when mounted, 150–175 × 150–165 µm, attached to the substrate by weakly pigmented, light brown to brown, thin-walled rhizoids, 2.5–3 µm diam.; TERMINAL HAIRS of one type—initially curved from the proximal end until up to half of its length, becoming strongly coiled toward the apex, making 7–12 (usually nine) convolutions, ≤30 µm diam., progressively smaller in diameter towards the apex ("corkscrew" type), olivaceous brown to golden, usually not becoming less pigmented close to the apex, extending up to 350 µm above the sporiferous head, 2.5–5 µm diam., finely punctate to verrucose, loosely clustered to form a weakly compact sporiferous head above the perithecium; LATERAL HAIRS scarce, filiform, tortuous, smooth to slightly punctate, usually setose, light brown to golden, slightly less pigmented than the terminal hairs, 3.5–4 µm, extending up to 150 µm, slightly bulbous at the base; PERIDIUM pseudoparenchymatous, membranaceous, fragile, with flattened, angular, slightly thick-walled cells, 4.5–12 µm diam.; ASCI 8-spored, clavate, spore-bearing part 32.5–37 × 7.5–12.5 µm, with a short stipe, evanescent; ASCOSPORES subglobose to limoniform, weakly biapiculate, light brown to olivaceous brown when mature, smooth, 8.5–9 × 5.5–7.5 µm.

SPECIMEN EXAMINED—**BRAZIL. PERNAMBUCO: Caruarru,** Instituto Agronômico de Pernambuco (IPA), Caruaru, on goat dung, 7.X.2011, R.F.R. Melo s.n. (URM86716).

DISTRIBUTION—Africa (Egypt, Iraq, Kenya, Kuwait, Libya, Swaziland, Sudan, Tanzania, Zambia), Asia (India, Japan, Malaysia), Europe (Czech Republic, England), North America (USA) and Oceania (Australia, New Zealand, Papua New Guinea). Probably worldwide. This is the first record for the Neotropics.

COMMENTS—Among similar *Chaetomium* species that present coiled "corkscrew" terminal hairs with convolutions progressively decreasing in diameter toward the apex, *C. spirale* differs from *C. convolutum* Chivers by its smaller, more globose perithecia and by the terminal hairs with more convolutions (7–12). It also differs from *C. cochliodes* by lacking a second type of terminal hair besides the coiled ones, and from *C. aterrimum* Ellis & Everh. ex Palliser in which the terminal hairs are uniform in diameter. The material presented here fits well the description provided by Ames (1961).

Sordariomycetes, Sordariales, Sordariaceae

Sordaria lappae Potebnia, Ann. Mycol. 5: 13 (1907) FIG. 2O–Q

PERITHECIA usually scattered, rarely isolated, semi-immersed to superficial, obpyriform to slightly obovoid, brown to golden, 475–550 × 300–315 µm, translucent, glabrous; neck cylindrical to papilliform, opaque, carbonaceous, dark brown to finally black close to the apex, 150–170 × 140–150 µm; PERIDIUM pseudo-parenchymatous, membranaceous, subopaque, darkening towards the neck to finally black—outer peridial layer with angular cells, thick-walled, 7.5–17.5 µm long, occasionally inflated; PARAPHYSES not observed; ASCI 8-spored, cylindrical, 160–190 × 16–17.5 µm, with a short stipe and tapered apex; ASCOSPORES obovoid to subglobose, light brown to golden when young, dark brown when mature, smooth, 18–22.5 × 15–17.5 µm, guttulate, with a basal germ pore, surrounded by a thin, hyaline gelatinous sheath except at the germ pore.

SPECIMENS EXAMINED—**BRAZIL. PERNAMBUCO: Recife,** Universidade Federal Rural de Pernambuco (UFRPE), on horse dung, 04.IV.2012, R.F.R. Melo s.n. (URM86770a, b).

DISTRIBUTION—Africa (Kenya, Tanzania, Uganda, Zaire), Europe (Czech Republic, England, Finland, France, Italy, Russia, Sweden), North America (Canada, USA) and South America (Argentina, Colombia). Possibly worldwide. This is the first record for Brazil.

COMMENTS—*Sordaria lappae*, although recorded in many countries, is of difficult determination. *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not. differs from *S. lappae* by its less brightly coloured peridium and less inflated cells and by its smaller and less apically rounded ascospores (15–22.5 × 10–12.5 µm) (Lundqvist 1972). The material from Brazil presents slightly wider ascospores when compared to the material described by Lundqvist (13–15 µm; 1972).

Discussion

Recent surveys and inventories examining understudied substrates in tropical areas has led to novel information on the geographical distribution of fungal species. Coprophilous fungi as an ecological group are considered to occur worldwide, but their occurrence is closely tied to herbivore occurrence, so the factors that determine their geographical range are still subject to discussion. Considering that the discovery of new fungal records is quite frequent, this group may serve as an indicator of the advances in taxonomical and ecological knowledge in a region. In the present study, representatives of three major ascomycete groups were recorded. *Sordariomycetes* represents a large clade, including non-lichenized ascomycetes with perithecial ascomata (Zhang & al. 2006). *Arnium hirtum* is known from Africa, Europe, and North America. The new record for South America suggests that this species may have a worldwide distribution. Members of *Chaetomium*, recently studied by Wang & al. (2016), were reported for the first time in South America. Although not specialized on dung, these fungi can be common in cellulose-rich substrates, and incubation in moist chambers could subvert limiting factors that would otherwise prevent its sampling and identification. *Leotiomycetes* contains mostly forms formerly known as inoperculate discomycetes: apothecial ascomycetes with asci with a non-operculum apical apparatus (Wang & al. 2006). *Thelebolales* is the main group of this class that occurs on herbivore dung. The discovery of *Coprotus albidus* updates the *Coprotus* species from Brazil recently studied by Melo & al. (2015a). Among the *Pezizomycetes*, usually regarded as "operculate discomycetes," *Ascobolaceae* species are the most well known on herbivore dung. The *Ascobolus castaneus* record is the most significant for the group, considering that *A. castaneus* was previously recorded only from China. Similarly, *Syncephalis* Tiegh. & G. Le Monn., a zygosporic mycoparasite of coprophilous ascomycetes previously recorded only in Taiwan, produced in Brazil two second worldwide records: *S. clavata* (Melo & al. 2011) and *S. obliqua* (Melo & al. 2015b). The coprophilous mycobiota of Brazil is obviously rich and diverse, and further studies will increase our understanding of their patterns of occurrence, distribution, and substrate not only in South America but on other continents as well.

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